

EVALUATION OF A PROGRAM TO CONTROL HYDATID DISEASE IN CENTRAL UTAH¹

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ABSTRACT.— A program to control hydatid disease in central Utah was evaluated by: (1) surveillance of infection in dogs and sheep, (2) questioning adult residents of two Sanpete County communities (Fountain Green and Spring City) about their knowledge of hydatid disease and their attitudes toward preventive measures, (3) interviewing local officials to evaluate the proposed implementation of proper community-wide measures, (4) analyzing records of prophylactic treatment of dogs with praziquantel, and (5) comparing scores of tests given to third and fourth grade students before and after they colored an educational pamphlet about hydatid disease.

Infection rates of *Echinococcus granulosus* in dogs brought to volunteer diagnostic clinics dropped from 28.3 percent in 1972 to 1.0 percent in 1979, but increased to 9.8 percent in 1981. This last rise was due mainly to the fact that some dogs were examined that belonged to range sheepmen who had either not attended a field clinic recently or had never attended at all. Prevalence of the parasite in slaughtered sheep decreased steadily from 13.2 percent in 1972 to 2.8 percent in 1981. With regard to the questionnaire phase of the project, 87.3 percent and 84.3 percent of the respondents understood the role of dogs in the life cycle of *E. granulosus* in Fountain Green and Spring City, respectively. Over 50 percent of the respondents of these two communities had worked directly with sheep sometime in their life. In general, residents were more willing to practice preventive measures involving sheep than they were to implement measures involving dogs alone. However, many of the recommended community-wide preventive measures were not implemented. With the coloring book, students answered an average of 62.5 percent of the questions correctly before they colored the pamphlet and 83.3 percent afterward. Overall, our results suggest that residents of Sanpete County are knowledgeable about hydatid disease and its mode of transmission, and that, in general, progress has been made in control of hydatid disease in central Utah.

Utah has had the most autochthonous cases of hydatidosis (39) in man reported from the contiguous United States (Crellin et al., 1982), with the first reported case diagnosed in 1944 (Carlquist and Dowell 1951). Studies on dogs, foxes, and coyotes were undertaken in the early 1950s to identify the definitive host, but these were unsuccessful (Butler and Grundmann 1951, Grundmann et al. 1953, Butler and Grundmann 1954). The normal hosts of *Echinococcus granulosus* in Utah (dogs and sheep) were revealed in 1969 as part of an investigation into the death of a nine-year old boy in the community of Herriman (Kahn et al. 1972), near Salt Lake City. Concurrently, parasitologists at Brigham Young University began surveillance of the parasite in dogs and sheep in central Utah (Fox et al. 1970, Andersen et al. 1973, Lovelless et al. 1978). As more work was done, it became apparent that the main foci of infection were in that area of Utah, especially

Sanpete County. As a result, a cooperative program to study and control hydatid disease in central Utah was begun in 1971 by personnel from Brigham Young University (Provo, Utah), the Utah Department of Health (Salt Lake City, Utah), and the Centers for Disease Control (Atlanta, Georgia) (Andersen et al. 1974).

MATERIALS AND METHODS

Description of Study Area

Sanpete County is in the center of Utah and has a total area of 4,136 sq km. A valley (1700 m elevation) bordered by mountains (3400 m elevation) runs the length of the county. There are 14,615 people in the county (U.S. Bureau of the Census 1980a), 90 percent of which are Mormons (The Church of Jesus Christ of Latter-day Saints) (Stinner et al. 1978). Unlike most farming regions in the

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United States, nearly all residents of Sanpete County, regardless of occupation, live in one of 13 communities which vary in population from 153 to 2807 (U.S. Bureau of the Census 1980a). In 1978 there were approximately 1950 dogs (Loveless et al. 1978) and 90,400 sheep in the county (U.S. Bureau of the Census 1980b). Agriculture is the principal industry, with an emphasis on turkeys and sheep. Range sheep herds are grazed in the mountains during summer, on the valley floor during spring and fall, and on the desert (100–200 km to the west) during winter. In addition to the range herds, there are also semirange herds that are confined during winter but grazed in the mountains during summer. There are also many small flocks confined on a year-round basis, which are usually made up of ewes obtained from range sheepmen (Crellin et al., 1982).

Description of Hydatid Disease Control Program

The main goals of the program have been reported previously (Andersen et al. 1974) and are summarized on Table 1. The educational portion of the program was accomplished through press releases, an article in the *National Woolgrower* (Andersen and Wallentine 1976), pamphlets distributed county-wide, talks to civic and church groups, and displays and personal counseling done during community screening clinics. A filmstrip and coloring book were developed as tools to educate children. Copies of the filmstrip were given to the audiovisual departments of

TABLE 1. Main goals of a program to control hydatid disease in Sanpete County, Utah.

COMMUNITY OBJECTIVES

1. Covering or fencing animal disposal pits at waste disposal sites
2. Eliminating stray or roving dogs
3. Conducting educational programs in local schools

INDIVIDUAL OBJECTIVES

1. Fostering a widespread understanding of the parasite's life cycle
 2. Advocating proper preventive measures such as not feeding sheep viscera to dogs, burning or burying sheep that die on the range, and not allowing dogs to roam
 3. Encouraging individuals to have themselves and their dogs checked for *E. granulosus* at yearly screening clinics
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the two school districts in Sanpete County, and in 1980 coloring books were distributed to all third and fourth grade students in eight elementary schools in the county. The overall goal of this portion of the program was to educate the residents about the life cycle of *E. granulosus*, and the proper measures that could be taken to prevent the disease.

Local governments were advised as to proper community-wide control measures, and it was their choice whether or not such measures were implemented. Included within this phase of the program was prophylactic treatment by a local veterinarian (Dr. M. John Ramsay) of dogs in the northern half of Sanpete County with bunamidine hydrochloride (1974–1978) and praziquantel (1979–1981).

Surveillance of dogs, sheep, and human beings was conducted in several areas of central Utah. Starting in 1971, clinics to examine dogs were held in communities in Sanpete County, and, in 1980 and 1981, on nearby mountain range lands (Table 2). In other areas (Summit and Utah counties), clinics were usually held at the sheep camp location. Dogs were dosed with arecoline hydrobromide, and the resulting purge was examined on site. Sheep were checked at slaughter for the presence of cysts by state meat inspectors, and the identification of cysts suspected was confirmed at the parasitology laboratory at Brigham Young University. Forty-nine coyotes (Andersen et al. 1973, Conder and Loveless 1978) and 74 deer (Jensen et al., 1982b) were also examined to assess their possible role as sylvatic reservoirs of infection. Immunodiagnostic clinics for human beings were conducted usually in conjunction with clinics for dogs (Klock et al. 1973, Barbour et al. 1978). Clinics were advertised in local newspapers, by posters placed in communities, and by letters and phone calls to sheepmen by individuals from the Utah Department of Health, BYU, and a local veterinarian's office.

Evaluation of Control Program

The effectiveness of the control measures was evaluated by monitoring trends in infection rates in dogs and sheep and the numbers of new cases diagnosed in human beings.

The success of holding screening clinics was evaluated partially by comparing the list of all those who brought dogs for examination with a complete list of all sheepmen in the region (Crellin et al., 1982). Further evaluation was obtained by questioning adult residents of two Sanpete County communities (Fountain Green and Spring City) concerning their knowledge of hydatid disease and attitudes towards proper preventive measures. The procedures employed in devising, distributing, and analyzing these questionnaires were described earlier (Condie et al., 1981). Implementation of community-wide measures was evaluated through interviews with city officials and visits to the various community waste disposal sites.

The effectiveness of the coloring books in increasing knowledge about hydatid disease and proper preventive measures was analyzed by testing the students before they received the coloring book and again two weeks afterward. Pre- and posttest scores were compared using a paired *t*-test.

RESULTS

Of 15,775 sheep slaughtered in five central Utah abattoirs since 1971, 1116 (7.1 percent) were infected with *E. granulosus*. The range in yearly prevalence was 13.2 percent in 1972 to 2.8 percent in 1980 and 1981 (Fig. 1). During the study period, 83 screening clinics

for dogs were held; 109 of 1120 (9.7 percent) dogs purged were infected with the adult cestode. Infection rates of the parasite in dogs declined from 28.3 percent in 1972 (Loveless et al. 1978) to 1.0 percent in 1979, but rose to 8.9 percent in 1980 and to 9.8 percent in 1981 (Fig. 1) (Jensen et al. 1982a). This rise, however, was probably due to the fact that in 1980 7 of the 8 dogs found infected were owned by sheepmen who had never attended a clinic, and that in 1981 4 of the 5 dogs infected were owned by sheepmen who had not attended a clinic in several years. Sixty of 593 (10.1 percent) owners who attended a clinic had at least one infected dog (Fig. 2 and Table 3). Generally, the proportion of owners with at least one infected dog was higher in communities from the northern half of the county (Table 3). Twenty-seven of the 28 (96.4 percent) range sheepmen presently in the county have taken some of their dogs to at least one clinic, but no more than 19 (67.8 percent) have attended in any one year. Seven clinics were held in Summit County where 6 of 69 (8.7 percent) dogs harbored *E. granulosus*, and one clinic was held in Utah County where 1 of 21 (4.8 percent) dogs was infected. No echinococcosis infections were found among 49 coyotes (Andersen et al. 1973, Conder and Loveless 1978) and 74 deer examined (Jensen et al. 1982b).

TABLE 2. Dogs infected with *Echinococcus granulosus* in Sanpete County, 1971-1981.

Community	Use of dog			
	Tending sheep		House pet	
	Dogs purged	Dogs infected (%)	Dogs purged	Dogs infected (%)
North Sanpete				
Fairview	70	14(20.0)	91	4(4.4)
Fountain Green	153	32(21.7)	67	3(4.5)
Mt. Pleasant	92	5(5.4)	31	2(6.5)
Spring City	81	16(19.8)	161	12(7.5)
Other communities	55	4(7.3)	33	0(0.0)
Area total	451	72(16.0)	383	21(5.5)
South Sanpete				
Ephraim	56	8(14.3)	21	0(0.0)
Manti	43	4(9.3)	96	1(1.0)
Mayfield	2	0(0.0)	37	0(0.0)
Gunnison	11	3(27.3)	20	0(0.0)
Area total	112	15(13.4)	174	1(0.6)
County total	563	87(15.4)	557	22(3.9)

TABLE 3. Dog owners in Sanpete County who have had dogs infected with *Echinococcus granulosus*, 1971-1981.

Region	Range sheepmen		Semirange sheepmen		Not sheepmen	
	No. of owners	No. with infected dogs (%)	No. of owners	No. with infected dogs (%)	No. of owners	No. with infected dogs (%)
North	25	16(64.0)	67	15(22.4)	285	21(7.4)
South	19	7(36.8)	12	1(8.3)	180	1(0.6)
Total	44	23(52.3)	79	16(20.3)	465	22(4.7)

Fourteen autochthonous cases of hydatid disease in man have been diagnosed in Sanpete County—an average annual incidence of 3.7 per 100,000 (Table 4). Twelve of these 14 cases were from the northern half of the county. The 7 cases in Fountain Green since 1952 translate to a prevalence of 50 per 100,000. Six of 2747 individuals in Sanpete County tested serologically for the presence of hydatid cysts were diagnosed to be asymptomatic carriers, and subsequently 4 of these 6 have had surgery (Barbour et al. 1978).

In the door-to-door surveys, responses were obtained from 140 of 156 (89.7 percent) and 147 of 176 (83.5 percent) households in Fountain Green and Spring City, respectively. In Fountain Green 256 individuals (1980 population of 578), and in Spring City 228 (1980 population of 675) returned completed questionnaires. Twenty-nine percent of the

respondents from Fountain Green indicated that they were aware of hydatid disease before 1971, but only 9.0 percent from Spring City were aware of this disease prior to that year. In Fountain Green, 87.3 percent of the respondents currently understood the role of dogs in the life cycle of *E. granulosus*, and 70.0 percent knew the role of sheep. In Spring City 84.3 percent understood the role of dogs and 69.0 percent knew the role of sheep. There were 62.0 percent and 54.0 percent of the adult residents of Fountain Green and Spring City, respectively, who had worked with sheep some time in their life. In Fountain Green 83.0 percent of the adult residents and in Spring City 77.5 percent were willing to pay to have a proper animal disposal pit built and maintained. Spring City residents were asked the reasons why they did or did not bring their dogs to clinics. The

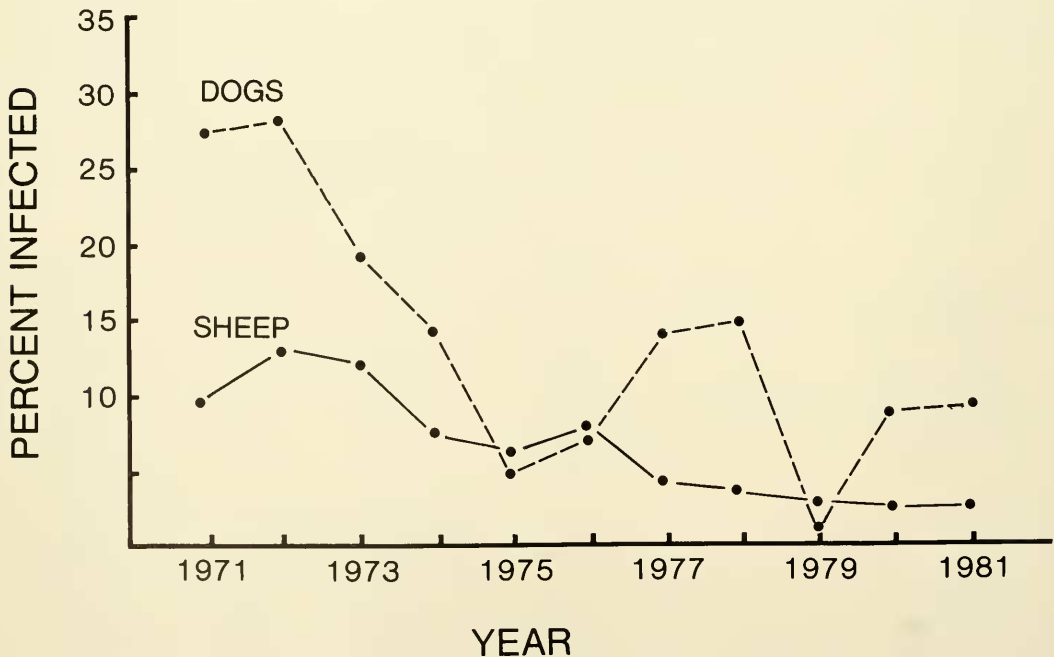
Fig. 1. Prevalence of *Echinococcus granulosus* in dogs and sheep from central Utah, 1971-1981.

TABLE 4. Fourteen autochthonous cases of hydatid disease in human beings from Sanpete County, Utah.

Name	Sex	Year of birth	City of residence	Connection with sheep raising	Year of surgery	Location of cyst
N.P.	F	1944	Fountain Green	Direct ^a	1952	Lung
J.B.	M	1916	Fountain Green	Direct	1964	Lung & Liver
P.A.	M	1946	Fountain Green	Direct	1967	Liver
P.J.	M	1931	Fountain Green	Direct	1971	Liver
L.C.	M	1949	Fountain Green	Direct	1971	Liver
M.C.	M	1908	Mt. Pleasant	Direct	1972	Lung
R.L.	M	1908	Mt. Pleasant	Direct	1973	Lung
D.J.	M	1960	Fountain Green	Indirect ^b	1974	Liver
R.C.	M	1913	Spring City	Direct	1975	Liver
D.A.	M	1921	Fountain Green	Direct	1975	Liver
B.S.	F	1967	Manti	Indirect	1976	Lung
D.D.	F	1955	Gunnison	Direct	None ^c	Liver
C.W.	F	1926	Spring City	Direct	None ^c	Liver
E.C.	M	1951	Fairview	Indirect	1979	Lung

^aPatient or family members are sheepmen.^bPatient lives near sheepmen.^cCase diagnosed in 1976.

desire to know if their dog was infected (93.9 percent) and their desire to eliminate hydatid disease (90.3 percent) were the reasons most commonly given for attending. Being unaware of the clinic (55.9 percent) and a lack of personal time (35.2 percent) were the reasons most frequently listed for not attending.

Data on sources of information (Table 5), attitudes and practices of dog and sheep owners (Table 6), and dog and sheep populations (Table 7) are also presented herein.

Implementation of community-wide preventive measures and participation in the praziquantel treatment program were gener-

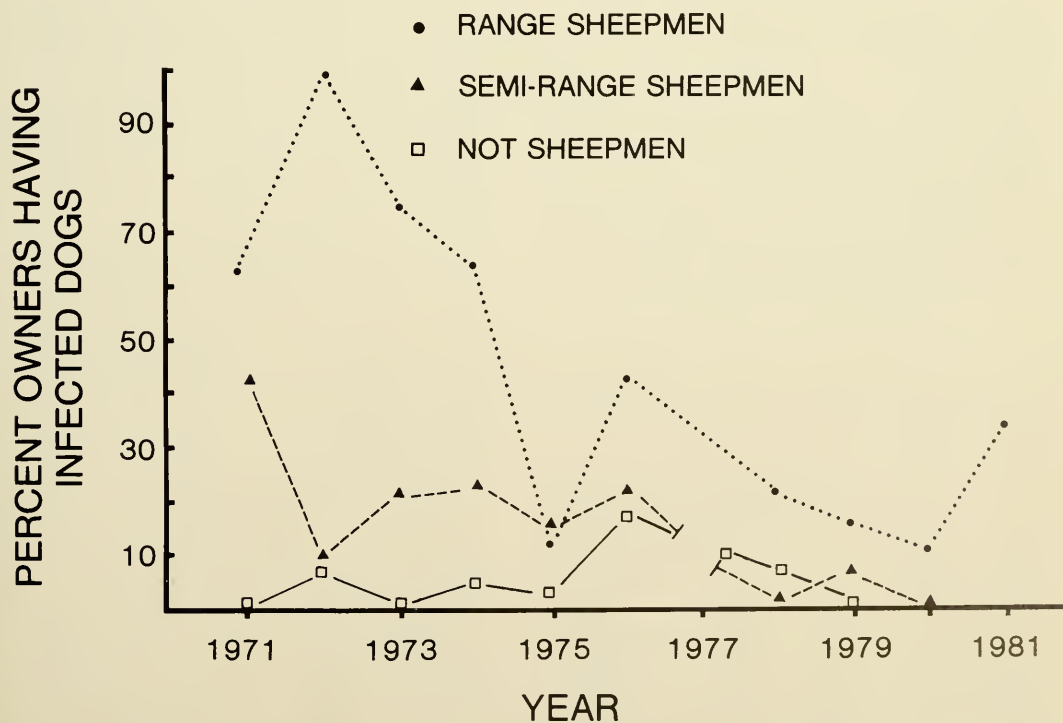


Fig. 2. Percent of individuals in Sanpete County, Utah, having dogs infected with *Echinococcus granulosus*, 1971-1981.

ally poor. Only one community (Spring City) of the six that had an animal disposal pit, had a pit cover. Two communities (Moroni and Manti) did not allow dead animals to be left at their waste disposal sites. Laws making it illegal to leave dead animals on the range were passed recently in Sanpete and five adjoining counties, but, at this time, enforcement is nonexistent. All communities have leash laws, but only one (Manti) has made an effort to eliminate stray dogs. Fairview, Fountain Green, Moroni, and Mt. Pleasant have enacted laws requiring treatment of dogs with praziquantel as a stipulation for obtaining or renewing a dog license; however, few sheepdogs in Sanpete County are licensed and compliance is largely voluntary. In the praziquantel treatment program, only 7 of 63 (11.1 percent) owners participating had ever had dogs known to be infected. Only 22 of the 63 (34.9 percent) owners had ever brought their dogs to a screening clinic.

DISCUSSION

Among the human population at risk in Sanpete County, cystic hydatid disease has been diagnosed at a rate (3.7 cases per 100,000 population per year) comparable to those in other regions regarded as highly endemic for this infection. Data for comparison include rates from the Australian state of Tasmania prior to the initiation of a statewide control program (15 per 100,000 per year; McConnell and Green 1979); from Cyprus (12.9 per 100,000 per year; Anonymous 1981); from Chile (7.8 per 100,000 per

year; Anonymous 1981); and from Yugoslavia (3.7 per 100,000 per year; Anonymous 1981). Also, infection rates in dogs and sheep at the beginning of the study period herein reviewed were similar to those in other endemic regions (Anonymous 1981).

Most successful programs to control *E. granulosus* have had both a formal organizational structure and a mandatory involvement of the local population (Gemmell 1979). In contrast, the control effort in central Utah has been a cooperative project involving university, state, and federal agencies, and participation of the community has been completely voluntary. The voluntary aspect of the program has imposed certain limitations on the rate of progress of suggested preventive and control measures. Although the majority of dog owners and sheep ranchers have responded positively to recommended measures, and also availed themselves of the diagnostic services provided, our questionnaire survey indicated that some individuals have not. The data indicate that the health educational aspects of the program have succeeded in making most adult residents of the two communities thoroughly aware of hydatid disease, but this may not be adequate to sustain interest and to motivate necessary changes. We had previously observed that most dog owners in Sanpete County were able to respond correctly to questions about the life cycle of

TABLE 5. Helpfulness of various sources of information about hydatid disease in Fountain Green and Spring City, Utah.

Source of information	Percentage of respondents who perceived source as helpful ^a	
	Fountain Green (%)	Spring City (%)
Screening clinics	70.8	56.3
Friends	60.2	47.8
Pamphlets	56.5	50.7
Veterinarian	51.6	32.7
Newspapers	23.5	36.7
Filmstrip	16.0	14.4
Physician	12.9	13.5

^aIndividuals who marked a "4" or "5" on a 1 (no help) to 5 (very helpful) scale.

TABLE 6. Attitudes and practices of dog and/or sheep owners in Fountain Green and Spring City, Utah.

Attitude or practice	Percentage of respondents	
	Fountain Green (%)	Spring City (%)
Attitude—willing to:		
take dog to clinic ^a	83.5	78.2
pay for prophylactic treatment of dog ^a	86.7	95.7
control dog ^a	48.8	65.0
use animal pit	88.0	87.8
Practice:		
allow dog to have access to area where sheep are killed ^b	21.6	11.0
butcher sheep at home or on range ^b	63.3	90.6

^aDog owners: Fountain Green, 64, and Spring City, 66.

^bSheep owners: Fountain Green, 34, and Spring City, 27.

hydatid disease and how to prevent it; however, many continue to manage their dogs in ways that permit them ready access to sources of infection (Schantz and Andersen 1980).

Another problem associated with the voluntary nature of our program involves the interpretation of data collected at diagnostic field clinics for dogs. Generally, rates of infection measured annually suggested a downward trend, although rates in most recent years have increased somewhat (Fig. 1). This apparent increase most likely reflects differences in the yearly samples of the canine population, rather than actual increases in rates of transmission. Some effort was made in the later years to encourage dog owners who had not previously attended to bring their animals to the voluntary clinics. Also, more diagnostic clinics were held in the summer sheep range land, rather than in local communities as was done previously. Thus, higher rates of infection were found in dogs not previously examined and in those sheep dogs that were from high-risk canine populations associated with herds of sheep.

In contrast to these fluctuating changes noted in the infection rates of dogs, a more steady decline was noted for the slaughtered sheep, and yet no changes in sheep marketing practices were known to occur during the study period.

It now seems likely to conclude that, after 10 years, *E. granulosus* has largely been eliminated from "house" dogs (those dogs not working with sheep), but is still found in small numbers in dogs owned by the county's sheepmen. This partial control has probably been achieved through educational efforts that resulted in a reduction in availability of sheep viscera to dogs. However, recommended preventive measures such as control

of dogs and proper disposal of dead animals have not been effectively implemented. The number of sheep in Sanpete County has dropped 38.5 percent since 1969 (U.S. Bureau of Census 1980b), and this could be a factor in the reduction in prevalence of *E. granulosus*. A drop in total sheep numbers was considered a factor in the elimination of hydatid disease from Iceland (Beard 1973).

In spite of the progress noted in our control program to date, there is still a continued potential for transmission of *E. granulosus* between dogs and human beings in Sanpete County. Basically, this is due to: (1) the lack of a county-wide control program for dogs, (2) the lack of adequately maintained animal disposal pits and covers in most of the communities, (3) the persistence of home-slaughtering of sheep, and (4) concentration of most county residents within communities. Our results, and those of an earlier study (Condie et al. 1981), suggest that individuals in central Utah are generally unwilling to control their dogs, but would be supportive of community efforts to build and maintain proper disposal pits for dead sheep.

In the future we plan to continue the distribution of all educational aids available, and also to encourage the community officials in those areas where hydatid disease has occurred to build and maintain proper animal disposal pits and covers. In addition, most clinics will be held closer to summer grazing areas, and sheepmen with a poor attendance record at clinics will be encouraged to have their dogs checked on a regular basis.

TABLE 7. Dog and sheep populations in Fountain Green and Spring City, Utah.

	Fountain Green	Spring City
Households with dogs	64/140	66/147
Number of dogs	109	101
Dogs per dog-owning household	1.7	1.5
Households with sheep	34/140	27/147
Number of sheep	24,317	3,655
Sheep per sheep-owning household	714	135

TABLE 8. Efficacy of coloring books as educational aids for third and fourth grade students in Sanpete County, Utah.

School	No. students	Average pretest score (%)	Average posttest score (%)
Fairview	47	57.3	79.6*
Fountain Green	6	51.7	83.3*
Moroni	50	66.6	80.8*
Mt. Pleasant/ Spring City	107	60.7	78.4*
Ephraim	63	64.4	88.1*
Gunnison	84	66.8	87.5*
Manti	56	59.5	86.6*
Total	413	62.5	83.3*

*Posttest score significantly greater than pretest score at $\alpha = 0.05$ using paired *t*-test.

Finally, since praziquantel (Droncit®) is now an approved drug in the United States, and since dog owners within the two communities surveyed indicated that they are willing to pay for treatment, we will encourage continued prophylactic treatment of dogs with this drug. Finally, surveillance of hydatid disease will be maintained by monitoring infection rates in slaughtered sheep and by registering diagnosed human cases.

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